

larly on the whole than the maxima and minima of sun-spots.

But why do we beat about the bush when all that is needed is half-a-dozen of Pouillet's pyrheliometers with skilled observers, who will seize every clear day to determine directly the heating power of the sun? Why do we not go direct to the Great Luminary himself, and ask him plainly whether he varies or not? If he answers No! then some of us must reconsider our theories, and perhaps endure a little ridicule. But if, as is much more probable, he should answer Yes! then the time will come when the most important news in the *Times* will be the usual cablegram of the solar power. Solar observatories ought to be established on the table-lands of Quito or Cuzco, in Cashmere, in Piazz Smyth's observatory on the Peak of Teneriffe, in Central Australia, or wherever else the sun can be observed most free from atmospheric opacity. An empire on which the sun never sets, and whose commerce pervades every port and creek of the sunny south, cannot wisely neglect to keep a watch on the great fountain of energy. From that sun, which is truly "of this great world both eye and soul," we derive our strength and our weakness, our success and our failure, our elation in commercial mania, and our despondency and ruin in commercial collapse.

W. STANLEY JEVONS

THE WERDERMANN ELECTRIC LIGHT

WE are able this week to give some further details concerning Mr. Werdermann's method of dividing the electric light.

The real difficulty was found in devising a form of light which *could* be divided into several, and still give enough illuminating power for practical use; and it is in this particular that Mr. Werdermann has apparently succeeded. It may be interesting here to state Mr. Werdermann's reasons for adopting this particular form of lighting.

When in an electric lamp, electrodes having the same sectional area are used, the changes at the points between which the voltaic arc passes, take place in a manner which is well known, viz., a crater or hollow is formed in the positive electrode which emits the light, the crater itself being heated by the current to white heat, and the surrounding part to redness. The negative electrode which assumes the form of a cone, is only heated to redness, and emits scarcely any light.

It was found that an increase in the sectional area of the positive electrode diminishes the light emitted by that electrode, and if the increase is continued gradually, the light on that electrode finally disappears entirely, whereas the heating effect upon the negative electrode in connection therewith increases, until finally light is emitted by the same. Again, by increasing the sectional area of the negative electrode, the heating effect upon the same decreases proportionally to the increase of its area, until the area having been sufficiently increased the heat almost entirely disappears, and consequently the consumption or wearing away of that electrode is scarcely appreciable.

The light given out by the positive electrode in connection therewith, on the contrary, increases in proportion to the difference existing between the sectional area of the two electrodes, and instead of a crater being formed in the positive carbon, the latter assumes the form of a cone as formerly was the case with the negative carbon. The greater the difference between the areas of the two carbons the shorter is the length of the voltaic arc which can be obtained between them, and when the area of the positive is gradually diminished and that of the negative increased, the light is produced by the carbons apparently in contact, and a small deposit of graphite is seen on the

negative electrode. The section of this deposit is about $\frac{1}{4}$ that of the positive carbon itself, and it is about $\frac{1}{8}$ of an inch high.

Mr. Werdermann was led to make these experiments by the idea that perhaps by altering the sectional area of the carbons a similar effect might be produced to that which is obtained in electrolysis when a plate is used as one electrode and a small wire at the other, and from the

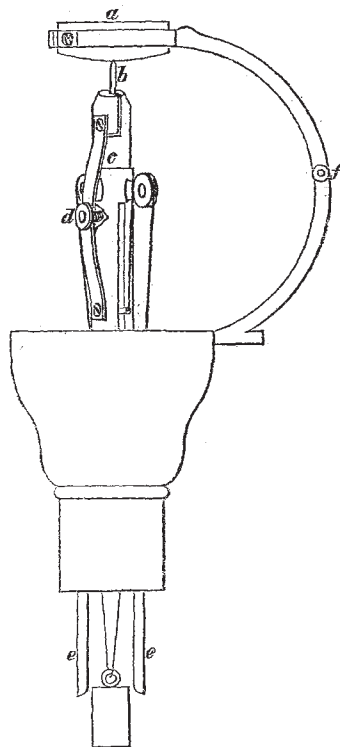


FIG. 1.

results obtained he devised his present system of electric lighting.

His lamp is constructed in the following manner:—

He places the negative carbon which is in the form of a disc 2 inches in diameter, and about 1 inch thick, uppermost. This carbon is clasped all round by a copper band which is prolonged to the terminal to which one of the leading cables is attached. The lower or positive electrode is a small pencil of carbon 3 millimetres in

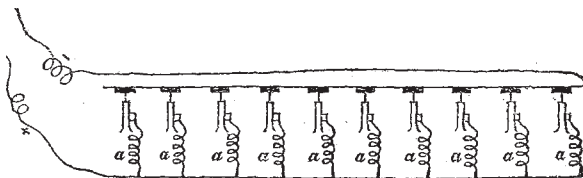


FIG. 2.

diameter, and can be made of any suitable length. This slides up vertically in a tube placed directly underneath the disc. This tube guides the pencil and also forms a contact for it, the top of the tube being solid copper in two pieces, one being rigid and the other pressing against the carbon by means of a regulating spring. The carbon pencil protrudes above the tube about $\frac{1}{4}$ of an inch, and touches the negative disc, and this length when the current passes is made incandescent.

The small carbon is pointed at its upper extremity and retains this point while burning. A small electric arc is formed round the points of junction, and to this is due the greater part of the light and not to incandescence alone. The carbons are kept in contact by chains attached to the lower end of the pencil passing over pulleys and down again to a weight of about $1\frac{1}{2}$ lbs., which is sufficient to keep the pencil pressing gently against the disc.

The sketch, Fig. 1, shows the arrangement of the lamp; *a* is the negative carbon, connected by the semicircular piece of metal *f* to the conductor *e* on the right-hand side which forms part of the lamp-post. The metal *f* is hinged so that the top carbon may be moved back when a globe is put on. *b* is the pencil or positive carbon sliding in the tube *c*, this tube being connected to the conductor *e* on left-hand side. The pressure of the contact upon the small carbon is regulated by the spring *d*. The tube is shown in perspective for greater clearness. The arrangement and details of the lamp being thus shown, we will now describe the experiments which have recently been exhibited at the works of the British Telegraph Manufactory in the Euston Road. The display was mostly of an experimental character, the lamps being somewhat different in construction to those which will be made use of in actual practice, but the principle remains the same. The chief object of the inventor was to demonstrate that a number of lights can be steadily maintained in one circuit. The first experiment tried was that of putting two large lamps such as will be used for street-lighting in circuit with a Gramme electro-plating machine. It may be here remarked that this is probably the first time that such a machine was ever used for the purpose of producing an electric light. The two lamps were said to give a light equal to 360 candles each, but they gave to all appearance a considerably higher illuminating power.

A pure white light was given out, perfectly steady, and showing none of the blue or purple rays observed so frequently in the ordinary form of electric arc. The wonderful steadiness of the light is one of its chief features. After burning for some considerable time the current was switched on to a row of ten smaller lamps arranged on a shelf. The light from each lamp was apparently of the same strength and the effect was very brilliant, but the total illuminating power was not nearly so great as in the case of the two larger ones. But it seemed to show that a form of light had been devised that could be split up into a considerable number of smaller ones, each of which could be made use of in a practical way. The ten lamps were estimated to have a lighting power of forty candles each, but this is probably somewhat above the mark. But the results obtained, both as regards the wonderful regularity of the lamps and the practical demonstration of dividing the light, seem to have been satisfactory; and the more remarkable from the fact of the weak electro-motive force of the machine, which is only equal to that of four Daniell's cells. More lamps could have been lighted even from this machine had they been at Mr. Werdermann's command, but of course with a diminution of light. When suitable machines have been constructed Mr. Werderman is confident of being able to put 50 or 100 lights in circuit, but he does not believe in the indefinite division of the current for lighting purposes.

The lights were all connected parallel, as shown in diagram, Fig. 2. The thick wires + and - connect the lamps with the machine, the first lamp on the + cable being last on the - wire. The spirals *a* are extra resistances put in the circuit of each lamp, the object being to render the divided current less sensitive to any slight variation in the resistance of the lamps themselves, due to unequal pressure of contact, &c. The resistance of each lamp, including the wire *a*, is about 0.39 ohms. The

resistance of the ten in parallel circuit about 0.037 ohms. The carbon pencil consumes at the rate of from $1\frac{1}{2}$ to 2 inches per hour in the small lamps; the large ones taking $4\frac{1}{2}$ millimetre carbons, consume about 2½ or 3 inches in the same time. The pencils are made in Paris, costing about 1 franc per yard, which length will last for twelve hours. The discs are of ordinary carbon.

However many lights may be in use, one, two, three, or any number can be put out without affecting the others, the regulation of the current being provided for by a switch attached to each lamp. But if necessary, the current which originally went through those that are extinguished can be added to those kept alight, of course increasing their illuminating power. The lamps are set in action simultaneously, can be as easily put out, and again re-lighted.

Returning again to the intensity of the light, it was stated that the large lamps were equal to 360 candles. Now the effect of this light upon the eyes is apparently not injurious, and it is Mr. Werdermann's intention to use only globes of ordinary glass, as in the present form of gas-lamps; by this means the loss of light will be very slight indeed as compared with other systems, where the loss is from 20 to 30 per cent., incurred by using opal or ground glass globes.

Owing to the very small electromotive force of the machine the insulation of the cables can easily be provided for, and Mr. Werdermann hopes, with sufficiently powerful machines, to be able to carry the current to a considerable distance without any appreciable loss.

In conclusion, it may be worth while giving a few details in regard to the Gramme machine used. It is an electro-plating machine of the old pattern, having four upright electro-magnets and two bobbins, one for feeding the electro-magnets, the other for taking off the light-producing current. The bobbins are wound with thick copper bands. The electromotive force, as before stated, is only equal to four Daniell's cells, and the resistance of the taking-off bobbin is about 0.008 ohms. The quantity of current produced is of course large.

It may be mentioned that the large lamps were connected parallel, but having no extra resistances, as in the case of the 10; their resistance is also a trifle less. The resistances given are when the lamps are not alight; when burning it would be somewhat less. The power required to drive the machine described is about two horse-power.

A curious fact about the light is that the top carbon is not consumed, or at any rate so slowly, that it is not noticeable; therefore, to all intent and purpose, the lower carbon only is wasted.

T. E. GATEHOUSE

DUPLExING THE ATLANTIC CABLE

THE simultaneous transmission of two telegraphic messages in opposite directions upon one wire, now known by the name of duplex telegraphy, dates back from the year 1853. In that year Dr. Gintl, the director of state telegraphs in Austria, described a method by which this feat could be accomplished, and in July of the same year the method suggested by Gintl was tried between Prague and Vienna. An improvement on this method was suggested by a German electrician, Frischen, by Messrs. Siemens and Halske, of Berlin, and other workers at this subject. Nevertheless, owing to practical difficulties, the experiments were little more than interesting additions to our knowledge. So little hope, indeed, was there of the practical realisation of this important matter that, in a standard work on telegraphy, published in 1867, after describing the early methods of duplex telegraphy, the author remarks:—"Systems of telegraphing in opposite directions and of telegraphing in the same